REMARKS/ARGUMENTS

In the Office Action mailed November 26, 2004, claims 1-13 were rejected under 35 USC § 102 in view of Ma (US Pat. No. 6,485,988). Claims 14-15 were rejected under 35 USC § 103 in view of Ma and further in view of Cooney III (US Pat. No. 5,930,655) and Biolsi (US Pat. No. 6,677,678).

Applicant has amended independent claims 1, 6, and 10 to recite that the barrier etch that employs the combination of N_20 and CH_3F gases to etch through the silicon nitride barrier layer at least partially etches the dielectric layer with the plasma formed from the N_20 and CH_3F gases. It is respectfully submitted that the amendments render the pending claims novel, nonobvious, and patentable over the cited art, alone or in combination.

The claimed invention is directed to a selective oxygen-free etching process for barrier materials, including the feature of using a nitrous oxide (N_2O) gas and a fluoromethane (CH_3F) gas mixture, where the barrier material consists essentially of silicon nitride and wherein the etch that etches the barrier layer at least partially etches the dielectric material.

Ma is directed to a method of forming a conductive contact to a top electrode. In particular, Ma teaches away from the use of a hydrogen-containing etchant for etching through the silicon nitride layer (one of 402, 404, and 406 in Ma). This is because, as disclosed in Ma at column 22 lines 7-9, "hydrogen may diffuse through the top electrode to the PZT material and may unfavorably alter the electrical and/or physical characteristic of this layer." If a hydrogen-containing gas chemistries is employed, Ma instructs that "[a] hydrogen-containing etchant may be used to etch a structure if a hydrogen barrier is situated between the etched structure and the capacitor dielectric." See Ma column 22, lines 27-30.

Since Ma teaches away from using a hydrogen-containing etchant for etching the silicon nitride barrier layer, or only use the hydrogen-containing etchant when a hydrogen barrier layer is present, one skilled in the art would not use the CH_3F/N_20 etchant to etch a barrier layer that consists essentially of silicon nitride in the manner claimed, particularly when a hydrogen barrier layer is not present (which allows the dielectric layer to be partially etched by the barrier etch using the plasma formed from the N_2O and CH_3F gases).

Cooney is directed to a fluorine-free barrier layer between conductor and insulator for degradation prevention. While Cooney mentions that the fluorine-free barrier layer (28, 51, or 53) may be silicon nitride, Cooney does not show the combination of etching a silicon nitride barrier layer using a fluorocarbon/nitrogen gas in the manner claimed and, therefore, does not cure the deficiency of Ma.

Biolsi is directed to a damascene structure using a sacrificial conductive layer. While Biolsi mentions a silicon nitride barrier layer, Biolsi points out that the barrier layer is etched using a conventional method (See col. 7, lines 18-21). Therefore, Biolsi also does not cure the deficiency of Ma and/or Cooney.

Prior Art Rejections

A rejection under 35 USC § 102 requires that the cited reference teach all the claimed elements. A rejection under 35 USC § 103 requires that the combined references suggest the claimed combination. (MPEP 706 and 2141 et seq.). Under the Graham test, three factors must be evaluated: the scope and content of the prior art; the differences between the prior art and the claimed invention; and the level or ordinary skill in the art. (MPEP 706 and 2141 et seq.).

Claims

There are three independent claims, 1, 6, and 10. Amended claim 1 is representative of the independent claims and recites:

> 1.(Currently Amended) A method of etching an integrated circuit (IC) structure having an etched dielectric material with an exposed barrier layer, wherein said barrier layer is composed of a material consisting essentially of silicon nitride and is disposed below said dielectric material, said method comprising:

feeding a nitrous oxide (N_2O) gas and a fluoromethane (CH_3F) gas into a reactor;

generating a plasma in said reactor;

etching said barrier layer, wherein said etching said barrier layer partially etches said etched dielectric material with said plasma generated from said N_2O gas and said CH_3F gas; and

generating a high selectivity between said barrier layer to said dielectric material.

As described above, the claims require that a barrier layer consisting essentially of silicon nitride be etched using a nitrous oxide (N_2O) gas and a fluoromethane (CH_3F) gas mixture. Furthermore, the claim requires that the etching of the barrier layer partially etches the etched dielectric material using the plasma generated from the N_20 and CH_3F gases. Support for this feature may be found in the specification as filed at, for example, page 17 lines 1-3.

Neither Ma alone, nor in combination with Cooney or Biolsi, teach the limitations presented in the independent claims in the manner claimed. Applicants note that Ma expressly teaches away from using a hydrogen-containing etchant to etch through the barrier layer.

This is because, as disclosed in Ma:

> "Typically, silicon nitride is etched using hydrogen-containing plasma, such as CHF.sub.3 or CH.sub.2 F.sub.2. Hence, during etching these layers to form the contact to the TiAlN layer and/or the top electrode of the capacitor, hydrogen may diffuse through the top electrode to the PZT material and may unfavorably alter the electrical and/or physical characteristics of this layer. Hence, the method and etchant of the instant invention involve a hydrogen-free etchant for the etching of the contact to the top electrode (i.e., etching through the silicon nitride layer and/or the AlO_x and/or AlN layers)." Emphasis added. See Ma column 22 lines 3-13

Ma instructs that if a hydrogen-containing etchant is used, a hydrogen barrier must be provided.

> "A hydrogen-containing etchant may be used to etch a structure if a hydrogen barrier is situated between the etched structure and the capacitor dielectric." Emphasis added. See Ma column 22 lines 27-30.

Claim 1, 6, and 10 as amended does not require the use of a hydrogen barrier to protect the dielectric layer and in fact allows the barrier etch that employs the plasma that is formed from N_2O/CH_3F gases to partially etch through the dielectric layer. Ma, as discussed, would require a hydrogen barrier to prevent such etching by the hydrogen-containing plasma. As such, it is respectfully submitted that claims 1, 6, and 10 are novel, nonobvious, and patentable over Ma, either alone or in combination with Cooney and/or Biolsi.

Furthermore, dependent claims 2-5, 7-9, and 11-15 incorporate the limitations of their respective base claims and all intervening claims. Therefore, the cited references also do not teach the limitations presented in the dependent claims. These dependent claims are also patentable in their own right since they recite additional novel and nonobvious features. Consequently, Applicant requests that the Examiner reconsider and withdraw the rejection of claims 1-15.

Conclusion

For the reasons set forth above, Applicant submits that the pending claims recite subject matter that is not taught or suggested by the references. Accordingly, Applicant requests that the Examiner reconsider and withdraw the rejections, and issue a notice of allowance. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at 408-257-5500.

If any additional petition is required to facilitate consideration of this amendment, please consider this communication a petition therefor. Further, if the Commissioner finds that additional fees are due to process this filing, then he/she is authorized to charge such fees, or credit any over-payments that may apply, to our Deposit Account No. 50-2284 (Order No. LMRX-P053).

Respectfully submitted,

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